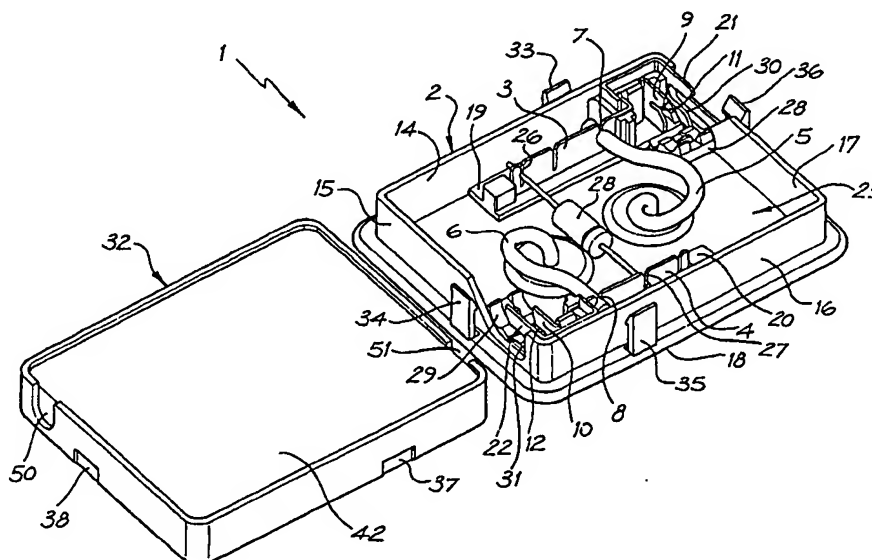


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(54) Title: SOLAR PANEL CABLE CONNECTOR



(57) Abstract

An electrical connector arrangement for use with panels such as photovoltaic solar panels comprises a housing (2) with openings for panel conductors (5, 6), having first Insulation Displacement Devices (3, 4) receiving the panel conductors (5, 6) in slots (7, 8) and second IDD (9, 10) receiving cable conductors in slots (11, 12) and being conductively connected to the first IDDs (3, 4). Further slots (26, 27) in the first IDDs (3, 4) may receive a diode (28). The arrangement allows assembly of the panel and connector arrangement in a factory and convenient wiring together of multiple panels on site. An IDD with a closure member having a buttress member to locate and maintain the cable conductor in place with respect to the IDD receiving slot is also disclosed.

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SOLAR PANEL CABLE CONNECTOR

FIELD OF THE INVENTION

The present invention relates to a panel connector
5 arrangement, and, particularly, but not exclusively, to a
panel connector arrangement for use with solar panels.

BACKGROUND OF THE INVENTION

In the electrical generating industry, it is known to
10 provide solar panels for the generation of electricity for
domestic and industrial use. Solar panels usually comprise
a series of conductively connected photovoltaic (solar)
cells arranged on a panel (usually a substantially flat
panel) to be mounted on a building to receive sunlight and
15 generate electricity. The panels are often connected in
series. This is usually done by connector modules in the
form of junction boxes which are mounted on the back of the
solar panels. Connector modules usually comprise a housing
mounting electromechanical connector arrangements for
20 conductively connecting cabling to panel conductors exiting
the solar panels. The cabling is used to connect connector
modules. The panel conductors which are provided exiting
the solar panels may be crimped to a male or female
connector member (e.g., plug/socket) mounted in the
25 connector module housing. A cooperating plug may be
mounted to the connecting cabling.

This arrangement is subject to a number of problems.

The photovoltaic cells of solar panels are connected
in series on installation. To do this, the panel
30 conductors which are already installed on the solar panels
need to first of all be mechanically connected to the male
or female connector member. This usually requires
crimping, which can be a difficult operation, particularly
in the confined spaces where the installation engineer

would usually operate e.g., in a roof cavity. Further, the connecting cabling which interconnects the flat panel connector modules must be connected to corresponding male/female connector members and, on installation, the male and female connector members are joined so that the cabling is connected to the panel conductors exiting the photovoltaic cells. The most convenient way to connect the cables to the cabling is to pre-cut the cables to the required length before installation and fit the appropriate male or female connectors to the ends of the cables. A problem with this is that when it comes to installation the connecting cabling may not be of ideal length. Indeed, to ensure that there is sufficient cabling there is usually an overestimate made as to the amount of cabling required, which results in a waste of cable and increase in expense.

This crimping and connecting operation can take a great deal of time and can be awkward to implement, particularly in the confined spaces available to the installation engineer, which generally means it takes quite a long time to install the arrangements, resulting in an increase in labour costs.

Another problem is with the conventional electro-mechanical connector, such as a plug-socket connector, the portion of the connector external to the box must be environmentally sealed. This increases complexity.

A housing is usually required for the connector module in order to protect the connection from the environment. It is desirable that the housing be as shallow and flat as possible, as there is only limited space available for mounting the connector modules. A problem with the presently available modules is that the housing must at least be deep enough to mount the electro-mechanical connectors, and this depth is usually quite significant.

SUMMARY OF THE INVENTION

The present invention provides a solar panel connector, comprising a housing including a base arranged to mount to a panel and walls upstanding from the base and defining an enclosure, the base further defining an opening through which a panel conductor extending from the panel may be received so that the panel conductor extends within the enclosure, and an insulation displacement device mounted within the enclosure for receiving a cable conductor for conductive connection to the panel conductor, the insulation displacement device being arranged to displace insulation from and make conductive connection with the cable conductor.

Preferably the solar panel connector further comprises conductive members incorporating receiving slots for receiving diode leads of a diode, the conductive members and insulation displacement device being arranged to connect the diodes to the cable conductor.

Preferably the housing further includes a lid for sealing the enclosure, a sealing gel being provided within the lid so that when the lid is closed the enclosure is sealed and insulated.

The present invention also provides an electrical connector for connecting panel conductors mounted to panels to cables for conducting electric current for providing electric power, the electrical connector comprising a housing mounting an insulation displacement device for receiving at least one of the power conductor and the cable to displace insulation therefrom and conductively connect the conductor and the cable.

Preferably, first and second insulation displacement devices are provided, the first insulation displacement device being arranged to receive the insulated panel conductor which is mounted to the panel to displace the insulation therefrom and electrically connect to a

conductive element (e.g., wire running within the insulation), and the second insulation displacement device being arranged to receive the insulated cable and displace the insulation therefrom and connect to a cable conductive element (e.g., wire running within the cable insulation). The first and second insulation displacement devices are conductively connected, so that, consequently, the panel conductor and cable conductor are conductively connected, whereby electric current may flow.

10 The insulation displacement device preferably comprises a pair of projecting portions defining a receiving slot, edges of the receiving slot being shaped to penetrate the insulation layer when a cable is forced into the receiving slot, similar to standard insulation
15 displacement devices.

Preferably, the panel is used to mount photovoltaic cells, and the panel conductors mounted to the panel are arranged to receive electric current generated by the photovoltaic cells.

20 Although the use of insulation displacement devices (IDDs) is known in the telecommunication industry, it is not known to use IDD in the solar panel power generating industry, for connecting solar panels, as far as the applicant is aware.

25 Flat panels, particularly solar panels may have different numbers of panel conductors for connection to external conductors (cable conductors). For example, some solar panels carry two separate sets of arrays of solar cells which need connecting within a circuit to external
30 conductors and this must be done by either three connections or four connections as is known. Further, diodes are used in the connections to prevent reverse flow of current through the solar cells.

A preferred embodiment of the present invention
35 provides a appropriate geometrical arrangement of the IDD

to facilitate connection of diodes within such connections. The arrangement preferably includes a third IDD mounted opposite the first IDD and including a receiving slot for receiving one terminal of a diode. The first IDD is
5 preferably provided with a further receiving slot positioned opposite to the receiving slot, for receiving the other terminal of the diode.

Preferably, the housing comprises a shallow box-like structure having a base mounting the IDD and a lid arranged
10 to fit to the base and cover it to environmentally seal the cable conductor/panel conductor connections.

Preferably, a sealing gel is provided to fill the housing and seal the connection from the environment. Again, use of a sealing gel is something which is known for
15 use in the telecommunications industry, but not in the solar panel power generating industry.

In a preferred embodiment, the sealing gel is mounted within a separate lid. On assembly, the cable and flat panel conductors are first of all connected by way of the
20 IDD and then the lid containing the gel is placed over the base. When the lid and the base are brought together the gel is forced into the space containing the IDD and connected conductors and seals the connection.

A panel may be substantially flat, as is usual with
25 solar panels, or maybe other than flat, e.g., curved, such as the curve of a car windscreen.

The connector of the present invention has the advantage that the housing can be made nearly as shallow as the width of the connecting cable. It does not have to be
30 deep enough to mount plug/socket type connectors, as in the prior art arrangements. The housing can therefore fit into a very narrow space.

Another advantage of the connector of the present invention is in assembly of the cable connections to the
35 connector. Because IDDs are employed, cable conductors do

not need to be pre-cut to a required length and mounted to plugs/socket type connectors before installation. Nor do the panel conductors need to be crimped to plug/socket type connectors. An installation engineer can cut the cables to
5 the appropriate length on site from, for example, a drum of raw cable. Installation is easy, merely requiring inserting the cables into the IDD, and closing a closure member (usually known as a "stuffer cap") with a pair of pliers. This results in simplicity, ease of assembly and a
10 consequent reduction in labour costs.

The panel conductors are usually assembled in the factory to the panel, by using a pair of pliers and a tool.

Rather than insulated wires extending from some panels, such as solar cell panels, for example, some panels
15 provide foil connectors. In one preferred embodiment of the present invention, as well as providing IDD's for conventional insulated panel conductors, lands are provided for connecting to foil panel conductors. This embodiment can therefore operate with panel types which provide
20 conventional insulated panel conductors for connection or panel types which provide foil conductors for connection.

The lands preferably have a hole or slot in them so that the foil conductor can be threaded through the land to provide a more secure connection prior to soldering.

25 In order to assist with inserting the (usually larger dimensioned) cable conductor into its IDD receiving slot, a closure member is preferably employed. The closure member is preferably a member which is hinged to a mounting on the connector proximate the cable conductor IDD receiving slot.
30 The cable conductor is inserted between the IDD and closure member and the closure member is then closed towards the IDD trapping the cable conductor and forcing it into place in the IDD receiving slot.

This operation can be awkward. It is usually
35 necessary for an operative to use two hands for at least a

time, one to place the cable conductor and maintain it in the correct position relative to the mouth of the IDD receiving slot and the other hand being used to operate pliers to force closed the closure member.

5 In a preferred embodiment of the present invention, a buttress member is provided mounted to the closure member, the buttress member being shaped to maintain the cable in the correct position with respect to the IDD receiving slot as the closure member is closed. The buttress member is
10 preferably shaped so that the force provided by the closure member is always in the same direction as the direction of the IDD receiving slot. This advantageously maintains the position of the cable conductor as the operator closes the closure member, facilitating operation with one hand.

15 A latching arrangement is also preferably provided for the closure member, which operates to latch the closure member in a first position, in which it is not closed, but in which it traps the cable conductor proximate the mouth of the IDD receiving slot. One hand can subsequently be
20 used to force the closure member shut, at the same time forcing the cable conductor into position within the IDD. The latching arrangement preferably includes a first latch means which latches the closure member in the first position where the cable conductor is trapped proximate the
25 IDD receiving slot and a second latch means which latches the closure member in a second position where the cable conductor is in position within the IDD receiving slot. The closure member assisting in maintaining the cable conductor within the IDD.

30 The present invention further provides a solar panel comprising a plurality of photovoltaic cells having panel conductors extending therefrom, the photovoltaic cells being connected by a plurality of electrical connectors, the electrical connectors comprising a housing mounting an
35 insulation displacement device for receiving at least one

of the panel conductors and a cable for connecting the panel conductors in series, to displace insulation therefrom and electrically connect the panel conductor and the cable.

5 The electrical connector employed in this aspect of the invention may have any or all of the features of the electrical connector discussed above.

10 The present invention yet further provides a method of connecting panel conductors mounted to a panel, for conducting electric current between the panel conductors for providing electric power, comprising the steps of employing insulation displacement devices for receiving at least one of a panel conductor and a cable for connecting to the panel conductor, to displace insulation therefrom
15 and electrically connect the panel conductor and the cable.

 An electrical connector in accordance with the embodiments of the invention described above may be employed in this method.

20 The present invention yet further provides a method of assembling electrical connections for a panel having panel conductors mounted thereto, the panel conductors being connected to a first insulation displacement device, the method comprising the steps of cutting a connecting cable to a required length and forcing the insulating connecting
25 cable into a second IDD connected to the first IDD, whereby to connect the panel conductor to the cable conductor.

 Preferably, an electrical connector in accordance with the present invention, as discussed above, is employed in this method of assembly.

30 The present invention further provides a junction box for connecting solar panels together, the junction box comprising a housing mounting a first insulation displacement device for receiving a panel conductor, a second insulation device for receiving a cable conductor,
35 whereby to connect the panel conductor to the cable

conductor, and a third insulation displacement device for receiving further panel conductors if they are present, the first and second insulation displacement devices being conductively connected, and the third insulation
5 displacement device being geometrically arranged with regard to the first insulation displacement device to enable connection of a diode between the first insulation displacement device and the third insulation displacement device, in order to electrically connect panel conductors.

10 The present invention further provides an arrangement for facilitating insertion of an insulated conductor into an insulation displacement device, comprising a closure member hingedly or slidably mounted proximate the insulation displacement device and having a buttress member mounted to
15 the face of the closure member, the buttress member being shaped to maintain the cable in the correct position with respect to an insulation displacement device receiving slot as the closure member is closed on the cable.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the present invention will become apparent from the following description of embodiments thereof, by way of example only, with reference to the accompanying drawings, in which:

25 Figure 1 is a perspective view of an electrical connector in accordance with an embodiment of the present invention, in disassembled form;

Figure 2 is a further perspective view of the electrical connector of figure 1;

30 Figure 3 is a detail of part of figure 1;

Figure 4 is a further detail corresponding to the detail of figure 3, but illustrating positioning of a cable conductor;

35 Figure 5 shows the detail of figure 3 with the cable conductor positioned within the receiving insulation

displacement device;

Figure 6 is a schematic diagram showing solar panels series connected by electrical connectors in accordance with embodiments of the present invention, and

5 Figure 7 is a perspective view from above of an electrical connector in accordance with a further embodiment of the present invention, in disassembled form.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 Referring to the figures, an electrical connector 1 in accordance with an embodiment of the present invention comprises a housing 2 mounting insulation displacement devices 3, 4. Each insulation displacement device 3, 4 is arranged to receive panel conductors 5, 6, in receiving
15 slots 7, 8. The insulation displacement devices (IDD's) are conductive, preferably being of metal, and the receiving slots 7, 8 have sharpened edges so that when the panel conductors 5, 6 are inserted in the slots 7, 8, the sides of the slots cut into the insulation of the panel
20 conductors 5, 6 and contact a conductive element (not shown) within the insulation.

 The housing 2 mounts second IDD's 9, 10 which are conductively connected to the first IDD 3, 4 and which may be integral therewith. The second IDD's 9, 10 are arranged
25 to receive cable conductors 40 (Figures 4, 5 and 6) for conductive connection to the panel conductors 5, 6. The cable connectors also have insulation and a conducting element 41 within the insulation. Receiving slots 11, 12 in the IDD 9, 10 are arranged to receive the cable
30 conductors 40 and cut into the insulation to contact the conductive element 41. In this way, the panel conductors 5, 6 can be connected to the cable conductors 40.

 The illustrated embodiment is particularly suitable for use with connecting photovoltaic cells in a solar
35 panel. Solar panels usually comprise a plurality of

photovoltaic cells. Each photovoltaic cell may have a pair of panel conductors mounted thereto. In order to obtain electric power from the photovoltaic cells it is necessary to connect the panel conductors to a further conductor
5 (usually a cable conductor) in order to carry electric current. Further, it is also usual to connect together the plurality of photovoltaic cells in a panel in series. This is done by series connecting the panel conductors via the cables, as illustrated schematically in Figure 6.

10 With this embodiment of the present invention, a plurality of electrical connectors in accordance with the described embodiment would usually be used for a single solar panel, the connectors being used to connect adjacent photovoltaic cells via cable conductors (Figure 6).

15 Describing the illustrated embodiment in more detail, the housing 2 of the electrical connector has walls 14, 15, 16, 17 upstanding from a base 18. Mounts 19, 20 are provided mounting the IDD's 3, 4, 9, 10. In addition the mounts 19, 20 mount respective cable strain relief members
20 21, 22 for relieving strain on the cable conductors 40.

Other than the mounts 19, 20, the walls 14, 15, 16, 17 and base 18 define a space 23. In operation, the base 18 is placed on the back of the solar panel where the panel conductors 5, 6 issue and is adhered to the back of the
25 solar panel by way of the back of the base 18.

The IDD 3, 4, as well as including receiving slots 7, 8 for the panel conductors 5, 6, include further receiving slots 24, 25, available for the receipt of further panel conductors should they be present. It will be appreciated
30 that any number of receiving slots and IDD's could be provided in the electrical connector, depending upon requirements.

Yet further receiving slots 26, 27 are arranged to connect to a diode 28, which is employed with solar panels

to prevent reverse current flowing back into the photovoltaic cells.

In operation, the panel conductors 5 and 6 are conductively connected to the IDD 3 and 4, as illustrated.

5 This assembly will usually be done in a factory when the junction box (electrical connector) is being fitted to a solar panel. Solar panels will then be assembled on site and the cable conductors will be fitted. Note that it is possible that total assembly (panel conductors and cable

10 conductors and junction box) could be done on site, but it is more likely that only the cable conductors will be connected to the junction box on site. The cable conductors 40 are placed in the mouth of the respective IDD slots 11 and 12, and a closure member 28, 29 is closed

15 towards the slot 11 forcing the cable conductor 40 into the slot to make conductive connection with the conductive element 41 of the cable conductor 40 and the conductive element of the panel conductor 5, 6 (see Figure 5, wherein the closure member 28 is shown in the closed position).

20 Pliers or a similar tool may be used for this operation. The strain relief members 21, 22 receive the cable conductors in a strain relief slot 30, 31, without cutting into the cable insulation, and provide strain relief in operation.

25 The electrical connector 1 also comprises a lid 32 which, in operation, closes over the walls 14, 15, 16, 17 of the housing 2. Upstanding tabs 33, 34, 35, 36 are provided and are received in corresponding slots 37, 38, 39 (a further slot is not shown in the drawings) in an

30 interface fit so that the lid 32 does not become removed from the housing 2 in operation. A further slot 40, 41 is provided for receiving the cable conductors. Further slots 50, 51 are provided for receiving the cable conductors 40. The further slots 50, 51 are shaped so as to fit closely

over the cable conductors 40 to facilitate environmental sealing with a gel.

The lid 32 is provided with a sealing gel 42 such as the type used in the telecommunications industry to seal
5 cables. The sealing gel is forced into the recesses within the housing 2 connected to the solar panel and surrounds and insulates all the components of the electrical connector, thus reducing environmental degradation of the connections.

10 As an alternative to using a sealing gel 42, environmental sealing could be provided by the use of a gasket in the lid of the box and corresponding gasket and slot in the housing. The gasket would provide the sealing and no sealing gel would be required.

15 A preferred embodiment of an electrical connector in accordance with the present invention is illustrated in figure 7. Figure 7 shows a base only of an electrical connector 50 and a separate lid will be provided, as with the embodiment of figures 1 through 6, but is not shown in
20 these drawings. This embodiment, as will become clear from the following description, also enables connection to panel conductors which are of the foil-type conductor, and provides an improved arrangement for connecting the cable conductor. This embodiment is also particularly adapted
25 for connection to 2, 3 or 4 panel conductors.

The electrical connector 50 comprises a housing 51 mounting a first set of insulation displacement devices 52, 53, a second set of insulation displacement devices 56, 57 and a third set of insulation displacement devices 54, 55.
30 Insulation displacement devices 52, 53, 54, 55 are arranged to receive insulated panel conductors in respective receiving slots 58, 61, 63, 64.

Flat panels, particular solar panels may have different numbers of conductors for connection to external
35 conductors. Some solar panels, for example, carry two

separate sets of arrays of solar cells which need connecting within a circuit to external conductors and this may be done by either three connectors or four connectors, as is known. Receiving slots 59, 62 and 60, 65,
5 respectively, are provided for receiving diodes for preventing reverse flow of current through the solar cells, in a known manner.

The geometry of the arrangement of the IDD's is such that the first IDD's 52 and 53 are positioned opposite the
10 third IDD's 54 and 55 so that the receiving slots 59, 62 and 60, 65 are opposite each other so that a diode can easily be inserted. For the purpose of illustration a diode 120 is shown mounted between slots 59 and 62. The third set of IDD's stands on its own and is not conductively connected to
15 any of the other sets of IDD's.

IDD's 57 and 56 are provided for receiving cable conductors to connect the solar panels to other solar panels and to an external circuit. IDD 56 includes a receiving slot 66 and IDD 57 includes a receiving slot 67.

20 IDD's 55 and 54, although connected together are not connected to IDD's 56 and 57. Connection of the circuit to the external conductors via IDD's 56 and 57 from IDD's 54 and 55 is by way of connection through the diodes (not shown) and IDD's 52 and 53. IDD's 54 and 55 are integral.

25 Similarly, first and second IDD's 52, 56 and 53, 57 are also integral.

If the panels employ foil conductors instead of insulated wire conductors, they can still be connected to the IDD conductors 52, 53, 54 and 55 by respective lands
30 68, 69, 70 and 71. The lands include slots 72, 73, 74, 75 through which the foil conductors may pass so that they can be soldered and firmly secured to the land 68, 69, 70, 71. The electrical connector 51, therefore, serves to be able to connect two different types of panel conductors.

The housing 51 comprises a base 80 and walls 81, 82, 83, 84. Mounts 85, 86, 87, 88, 89 are provided mounting the respective IDD's. A space 90 is defined by the walls for receiving conductors from the solar panels.

5 Only a single cable conductor 91 is shown being received in the electrical connector, but it will be appreciated that two cable conductors may be received in the respective IDD's 56 and 57. The cable conductor 91 is received via a slot 92 and wall 84. A further slot 93 is
10 also provided in wall 84 for receiving a second cable conductor (not shown). Closure members 94, 95 are provided for assisting forcing the cable conductors into the respective receiving slots 66 and 67.

 A latching arrangement is provided to facilitate
15 positioning of the cable conductors. The latching arrangement for IDD 57 comprises a panel 100 including a first latching projection 101 and a second latching projection 102. A cooperating projection 103 on the closure member 94 enables the closure member to be latched
20 in a first position (on latching projection 101) and a second position (on latching projection 102). In the first position, the closure member 94 is not closed but traps the cable conductor 91 proximate the mouth of the receiving slot 67. An operator can thus position the cable conductor
25 against the mouth of receiving slot 67 and hold it with the closure member 94. Without the latching arrangement the operator would need to use, in most cases, two hands to ensure that the cable conductor 91 maintains a correct position with respect to the receiving slots 67 as the
30 closure member is forced closed. With the latching arrangement the operator does not need to do this. Maintenance of the position of a cable conductor 91 is assisted by buttresses 106, 107 which are shaped to project towards the centre of the closure member but to taper
35 backwards towards the edges. The buttress member operates

such that the force provided by the closure member is always in the same direction as the direction of the IDD receiving slot, so that the cable is maintained in the correct orientation.

5 In the second latch position, the closure member is closed and maintains the cable conductor 91 within the receiving slot 67.

A similar latching and buttress arrangement 110, 111, 112, 113, 114, 115 is provided for the IDD 56.

10 It will be appreciated that the electrical connector of the present invention may be used with other flat panel arrangements which require conductive connection, and is not limited for use with photovoltaic cells and solar panels. For example, the electrical connectors could be
15 used with a flat glass panel plasma display or a curved windscreen of a car. Any application which requires connection of conductors issuing from a panel or body is suited for the electrical connector arrangement of the present invention.

20 The electrical connector of the present invention may be used, generally, with any arrangement where conductors issue from a surface and need connecting. The surface may be flat or curved and need not be but may generally be part of a panel. When interpreting the word "panel" as used
25 throughout this specification, therefore, it should be taken to include a surface which conductors issue from.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments
30 without departing from the spirit or scope of the invention as broadly described. For example, the closure member 28, 29 may be either hinged, such as by a "living" plastics hinge, or slidably coupled to the mount 19, 20. The present embodiments are, therefore, to be considered in all
35 respects as illustrative and not restrictive.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A solar panel connector, comprising a housing including a base arranged to mount to a panel and walls upstanding from the base and defining an enclosure, the base further defining an opening through which a panel conductor extending from the panel may be received so that the panel conductor extends within the enclosure, and an insulation displacement device mounted within the enclosure for receiving a cable conductor for conductive connection to the panel conductor, the insulation displacement device being arranged to displace insulation from and make conductive connection with the cable conductor.

2. A solar panel connector in accordance with claim 1, including conductive members incorporating receiving slots for receiving diode leads of a diode, the conductive members and insulation displacement device being arranged to connect the diodes to the cable conductor.

3. A solar panel connector in accordance with claim 1 or claim 2, the housing further including a lid for sealing the enclosure, a sealing gel being provided within the lid so that when the lid is closed the enclosure is sealed and insulated.

4. An electrical connector for connecting panel conductors mounted to panels to cables for conducting electric current for providing electric power, the electrical connector comprising a housing mounting an insulation displacement device for receiving at least one of the panel conductor and the cable to displace insulation therefrom and conductively connect the conductor and the cable.

5. An electrical connector in accordance with claim 4, wherein the insulation displacement device comprises a first insulation displacement device for receiving the panel conductor and connecting to a conductive element of

the panel conductor, and a second insulation displacement device for receiving the cable conductor and connecting to a conductive element of the cable conductor, the first and second insulation displacement devices being conductively
5 connected.

6. An electrical connector in accordance with claim 4 or claim 5, further comprising a strain relief member for relieving strain from the cable conductor.

7. An electrical connector in accordance with any
10 one of claims 4 to 6, wherein the housing includes a lid for sealing a space containing the insulation displacement device and electrical connections.

8. An electrical connector in accordance with any one of claims 4 to 7, wherein a sealing gel is provided to
15 seal the electrical connection.

9. An electrical connector in accordance with any one of claims 5 to 8, further comprising a third insulation displacement device for receiving further panel conductors where they are provided, the third insulation device also
20 being arranged to receive a terminal of a diode for conductively connecting panel conductors together, the first and third insulation displacement device being geometrically arranged so that the first insulation displacement device can receive the other terminal of the
25 diode.

10. An electrical connector in accordance with claim 9, wherein the third insulation displacement device is mounted opposite the first insulation device and includes a receiving slot for receiving one terminal of a diode, the
30 first insulation device having a further receiving slot positioned opposite to the receiving slot, for receiving the other terminal of the diode.

11. An electrical connector in accordance with any one of claims 4 to 10, further comprising a plurality of
35 conductive lands for receiving foil-type panel conductors

for securing thereto.

12. An electrical connector in accordance with any one of claims 4 to 11, further comprising a closure member for facilitating positioning of a conductor within the insulation displacement device, the closure member being hinged or slidably coupled to a mounting proximate the insulation displacement device and including a buttress member mounted to a face of the closure member, the buttress member being shaped to maintain the conductor in the correct position with respect to the IDD receiving slot as the closure member is closed.

13. An electrical connector in accordance with claim 12, the buttress member being shaped so that the force provided by the closure member is always in the same direction as the direction of the IDD receiving slot as the closure member is closed.

14. An electrical connector in accordance with any one of claims 4 to 13, further comprising a latching arrangement for facilitating positioning of a conductor within the insulation displacement device, the latching arrangement comprising a first latch means for latching a closure member in a first position against the conductor, in which position the closure member is not closed but the conductor is trapped proximate the mouth of the insulation displacement device, whereby an operator may subsequently use one hand to force the closure member shut at the same time forcing the conductor into position within the IDD.

15. An electrical connector in accordance with claim 14, wherein the latching arrangement further comprises a second latch means which latches the closure member in a second position where the cable conductor is within position within the IDD, the closure member assisting in maintaining the cable conductor within the IDD.

16. A plurality of solar panels, each comprising a plurality of photovoltaic cells having panel conductors

extending therefrom, the panels being connected by a plurality of electrical connectors in accordance with any one of claims 4 to 15.

17. A method of connecting panel conductors mounted
5 to a panel, for conducting electric current between the panel conductors for providing electric power, comprising the steps of employing insulation displacement devices for receiving at least one of a panel conductor and a cable for
10 connecting to the panel conductor, to displace insulation therefrom and electrically connect the panel conductor and the cable.

18. A method of assembling electrical connections for a panel having panel conductors mounted thereto, the panel conductors being connected to a first insulation
15 displacement device, the method comprising the steps of cutting a connecting cable to a required length and forcing the insulating connecting cable into a second IDD connected to the first IDD, whereby to connect the panel conductor to the cable conductor.

20 19. A junction box for connecting solar panels together, the junction box comprising a housing mounting a first insulation displacement device for receiving a panel conductor, a second insulation device for receiving a cable conductor, whereby to connect the panel conductor to the
25 cable conductor, and a third insulation displacement device for receiving further panel conductors if they are present, the first and second insulation displacement devices being conductively connected, and the third insulation displacement device being geometrically arranged with
30 regard to the first insulation displacement device to enable connection of a diode between the first insulation displacement device and the third insulation displacement device, in order to electrically connect panel conductors.

20. A junction box in accordance with claim 19,
35 wherein the third insulation displacement device is mounted

opposite the first insulation displacement device and includes a receiving slot for receiving one terminal of the diode, the first insulation displacement device having a further receiving slot positioned opposite to the first receiving slot, for receiving the other terminal of the diode.

21. An arrangement for facilitating insertion of an insulated conductor into an insulation displacement device, comprising a closure member hingedly or slidably mounted proximate the insulation displacement device and having a buttress member mounted to the face of the closure member, the buttress member being shaped to maintain the cable in the correct position with respect to an insulation displacement device receiving slot as the closure member is closed on the cable.

22. An arrangement in accordance with claim 21, the buttress member being shaped so that the force provided by the closure member is always in the same direction as the direction of the insulation displacement device receiving slot.

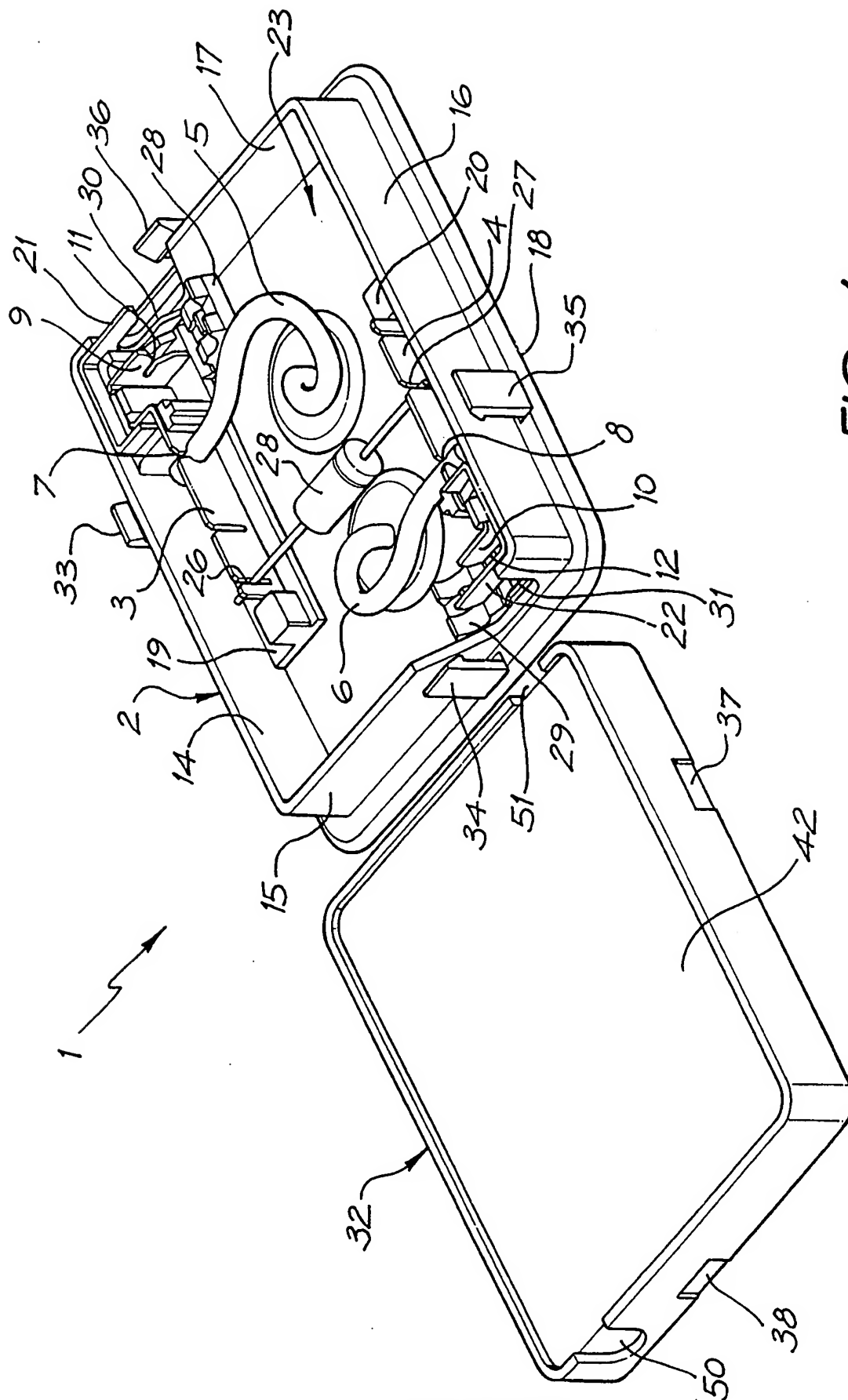


FIG. 1

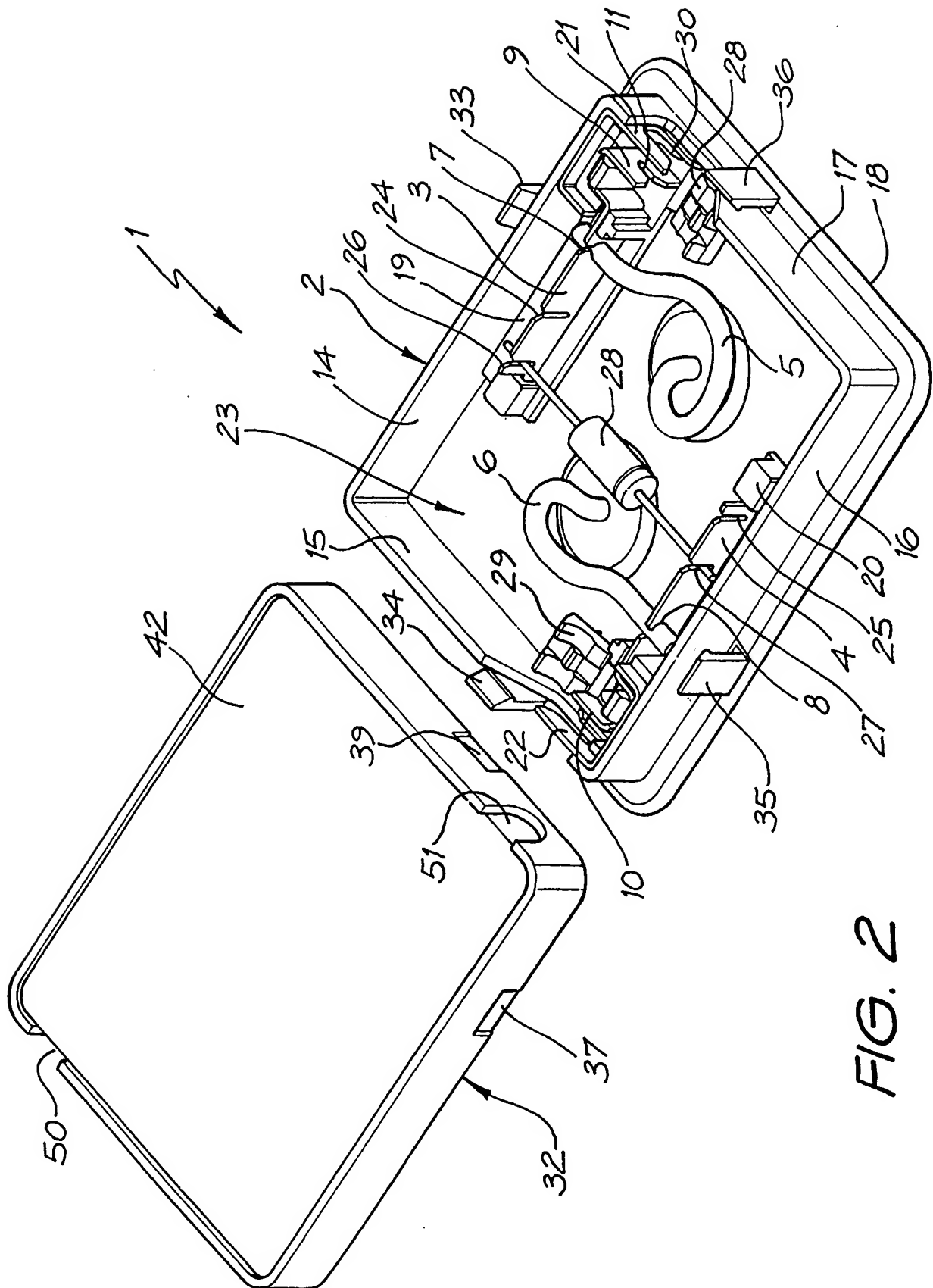


FIG. 2

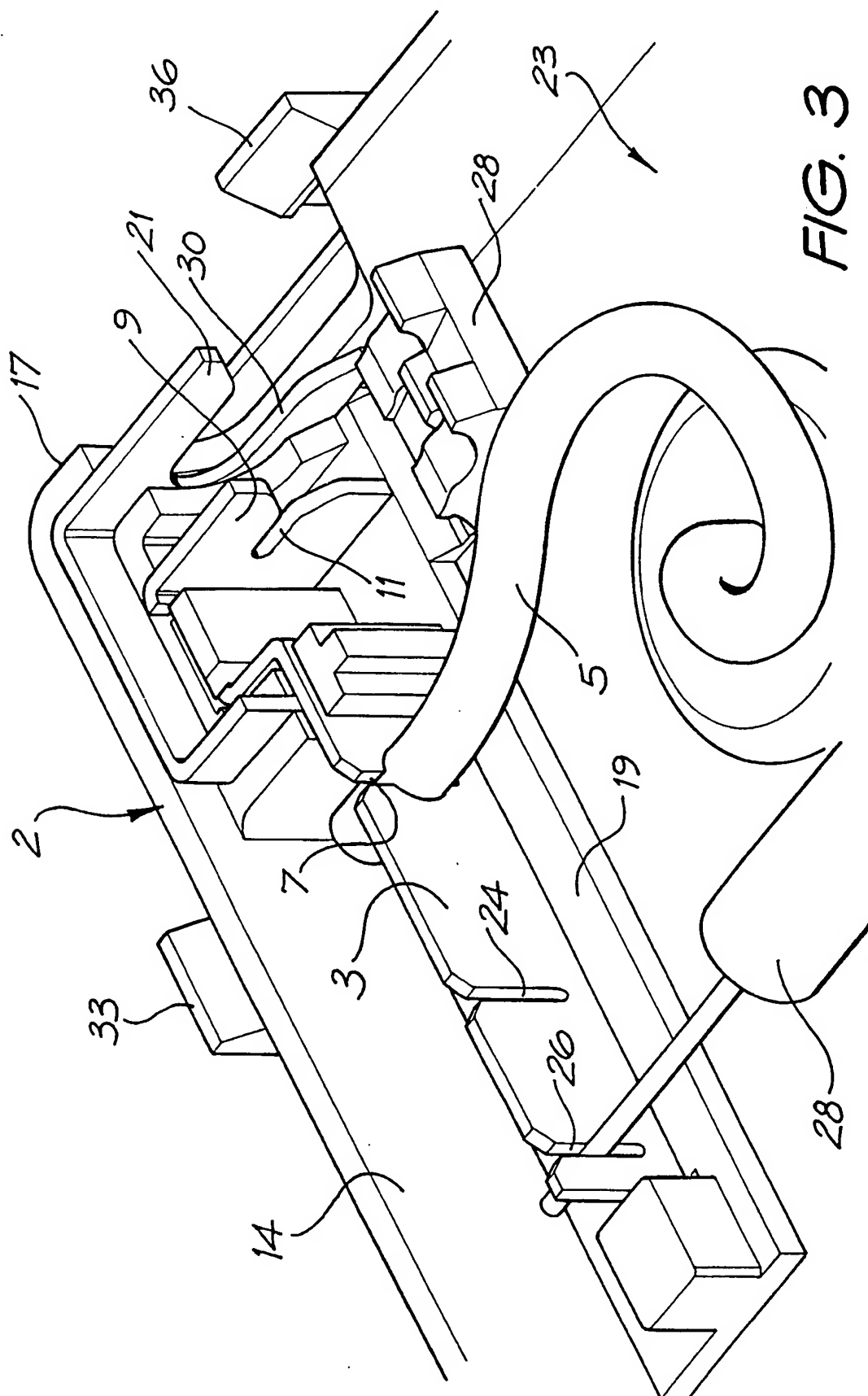


FIG. 3

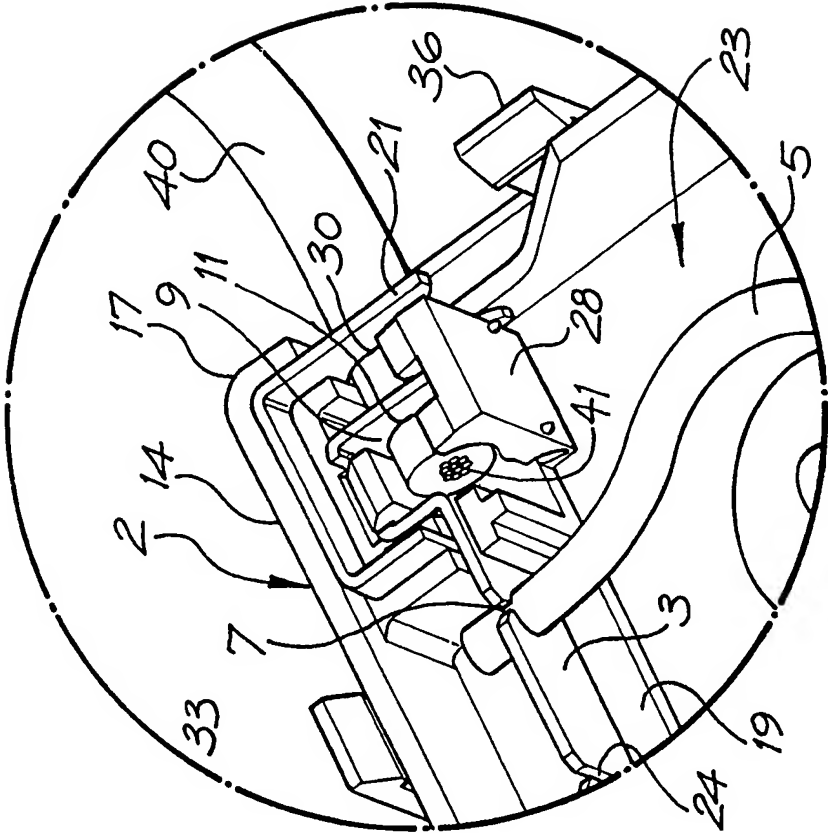


FIG. 5

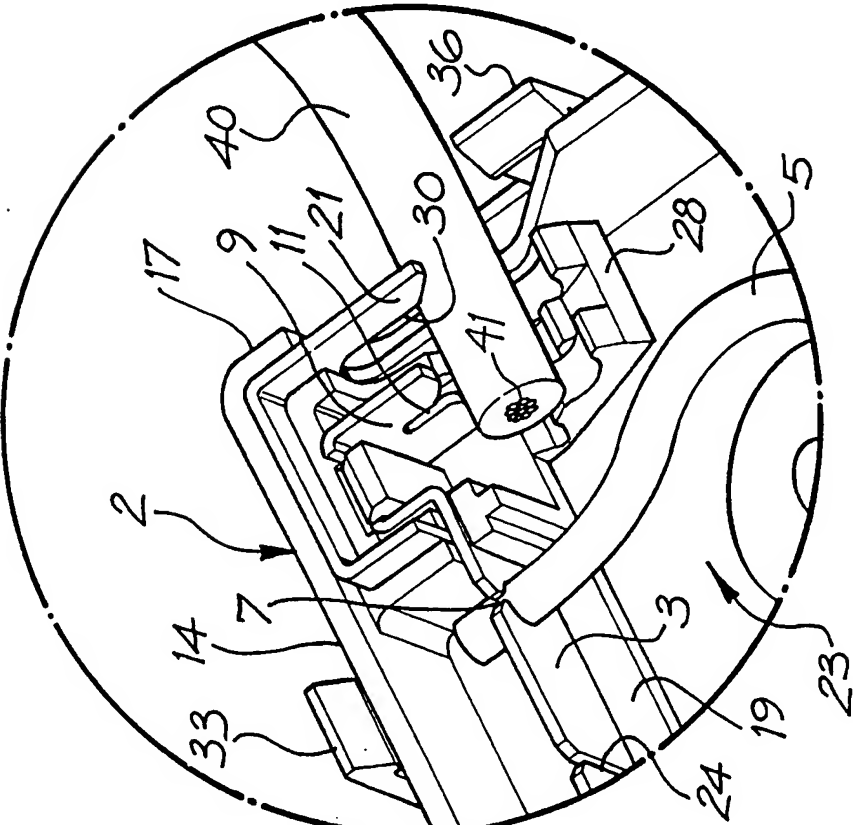


FIG. 4

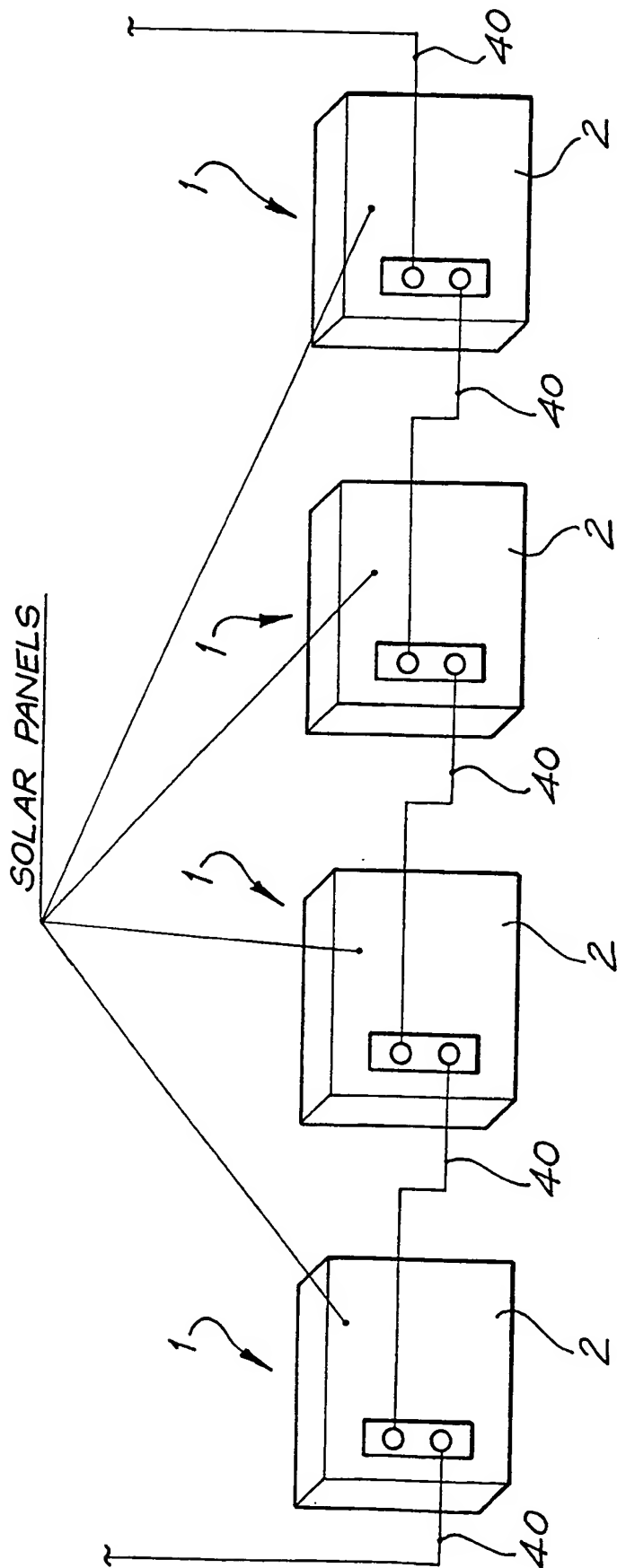


FIG. 6

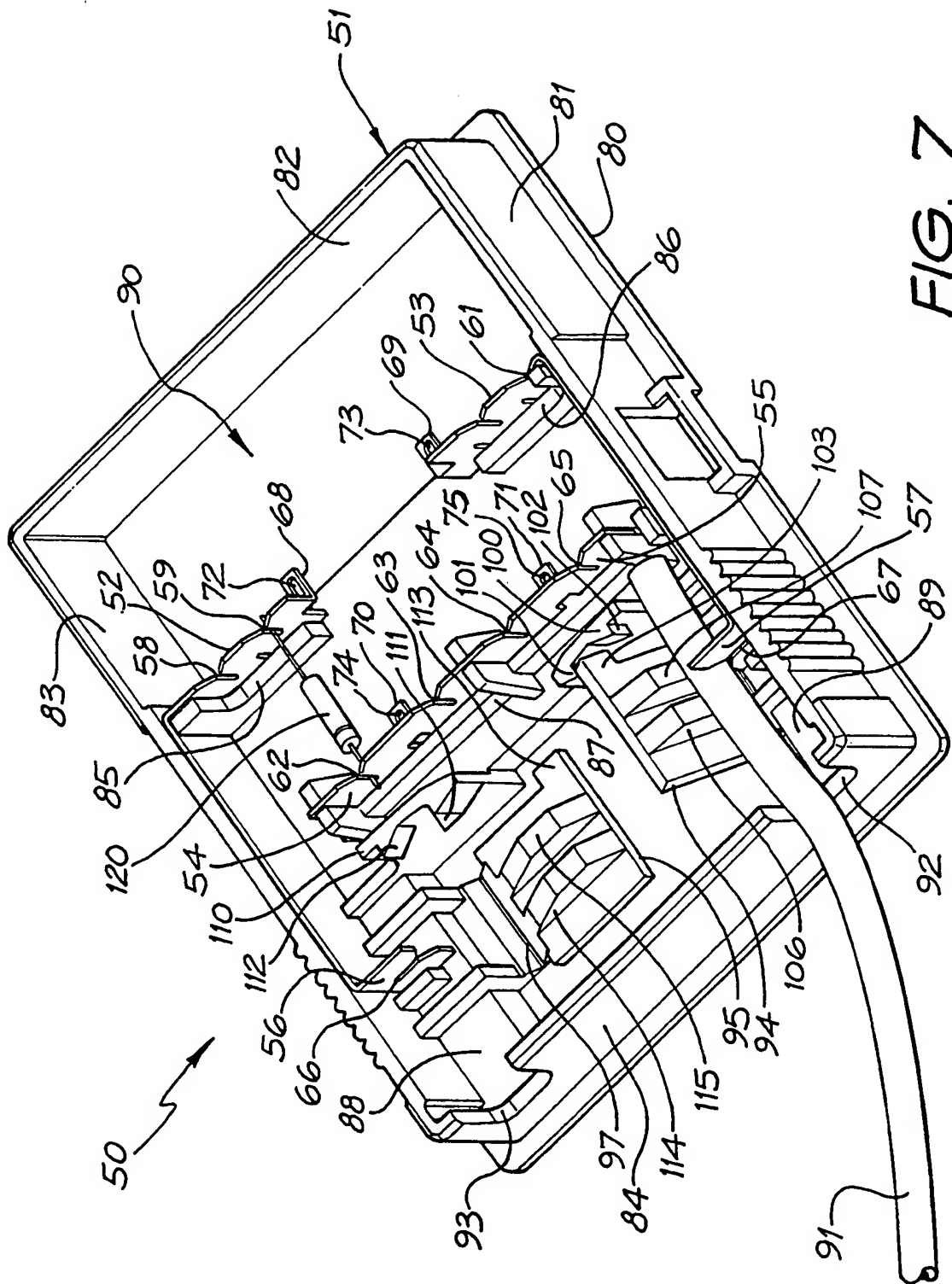


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/01018

A. CLASSIFICATION OF SUBJECT MATTER												
Int Cl ⁶ : H01R 4/24, H01L 31/05, H02G 3/08, 15/10												
According to International Patent Classification (IPC) or to both national classification and IPC												
B. FIELDS SEARCHED												
Minimum documentation searched (classification system followed by classification symbols) IPC H01R 4/24, 4/26, 11/-, 13/56, 13/58, H01L 31/05, H02G 3/08, 15/10												
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched												
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPAT												
C. DOCUMENTS CONSIDERED TO BE RELEVANT												
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.										
X	US 5147217 A (NEALE et al) 15 September 1992 whole document	4-8										
X	US 5080606 A (BURKARD) 14 January 1992 whole document	4-8										
X	US 4274696 A (LONG et al) 23 June 1981 whole document	4-7										
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex												
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td>"A" document defining the general state of the art which is not considered to be of particular relevance</td> <td>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</td> </tr> <tr> <td>"E" earlier application or patent but published on or after the international filing date</td> <td>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</td> </tr> <tr> <td>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</td> <td>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</td> </tr> <tr> <td>"O" document referring to an oral disclosure, use, exhibition or other means</td> <td>"&" document member of the same patent family</td> </tr> <tr> <td>"P" document published prior to the international filing date but later than the priority date claimed</td> <td></td> </tr> </table>			"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	"P" document published prior to the international filing date but later than the priority date claimed	
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention											
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone											
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art											
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family											
"P" document published prior to the international filing date but later than the priority date claimed												
Date of the actual completion of the international search 19 January 2000		Date of mailing of the international search report 25 January 2000										
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer DEREK BUTLER Telephone No.: (02) 6283 2347										

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/01018

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3804971 A (BAZILLE) 16 April 1974 whole document, particularly figures 3-5	21, 22
X	EP 452220 A (SAUER) 16 October 1991 whole document	21, 22

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/01018

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU 99/01018

Box II: Observations where unity of invention is lacking**Continued:**

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-20 are directed to connectors and their use for connecting panels such as solar panels, wherein the connectors comprise insulation displacement devices in a housing arranged to connect the panel cables to conductor cables. It is considered that a housing with insulation displacement devices arranged to connect panel cables to conductor cables comprises a first "special technical feature".
2. Claims 21 and 22 are directed to an insulation displacement device with a closure member having a buttress member to locate and maintain a conductor cable with respect to the insulation displacement device slot. It is considered that the form of the insulation displacement device closure member comprises a second "special technical feature".

These groups are not so linked as to form a single general inventive concept, that is, they do not have any common inventive features, which define a contribution over the prior art. The common concept linking together these groups of claims is the use of an insulation displacement device. However this concept is not novel in the light of insulation displacement devices per se. Therefore these claims lack unity a posteriori.

Information on patent family members

PCT/AU 99/01018

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	5147217	EP	519534	JP	5182699		
US	5080606	CA	2087133	EP	556265	PT	99416
		WO	9208256				
US	4274696						
US	3804971	AU	43949/72	CA	963552	CH	543817
		DE	2232311	ES	403986	FR	2144322
		GB	1381938	IT	958547	NL	7208250
		ZA	7204430				
EP	452220	AU	74374/91	FI	911659	FR	2661046
		NZ	237815	PT	97351		

END OF ANNEX